MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 2, 2019/2020

EMF4076 – ELECTROMAGNETIC INTERFERENCE

(TE & EE)

7 MARCH 2020
2.30 PM – 4.30 PM
(2 Hours)

INSTRUCTION TO STUDENT

1. This Question paper consists of 5 pages including cover page with 4 Questions only.

2. Attempt all **FOUR** questions. All questions carry equal marks and the distribution of the marks for each question is given.

3. Please print all your answers in the answer Booklet provided.

Question 1

(a) Explain the term Electromagnetic Compatibility (EMC).

[2 marks]

(b) List the THREE basic elements that must exist for electromagnetic interference to occur and explain the significance of recognizing these elements.

[5 marks]

(c) Figure Q1 shows a three-wire cable which forms an electromagnetic interference (EMI) generator circuit and an EMI receptor circuit, sharing a common ground return.

(i) Using the equivalent circuit of capacitive and inductive couplings, determine the expression of the total noise voltage, V_N.

[9 marks]

(ii) Given that V_s = 5 V and the per-unit-length mutual inductance and capacitance are l_{12} = 0.24 μH/m and c_{12} = 6.27 pF/m, respectively. Determine the noise voltage V_N if $R_{S2} = R_{L1} = R_{L2} = 50\ \Omega$.

[6 marks]

(iii) If the receptor wire is replaced by a shielded wire, explain whether the shield is effective if it is grounded only at one end.

[3 marks]

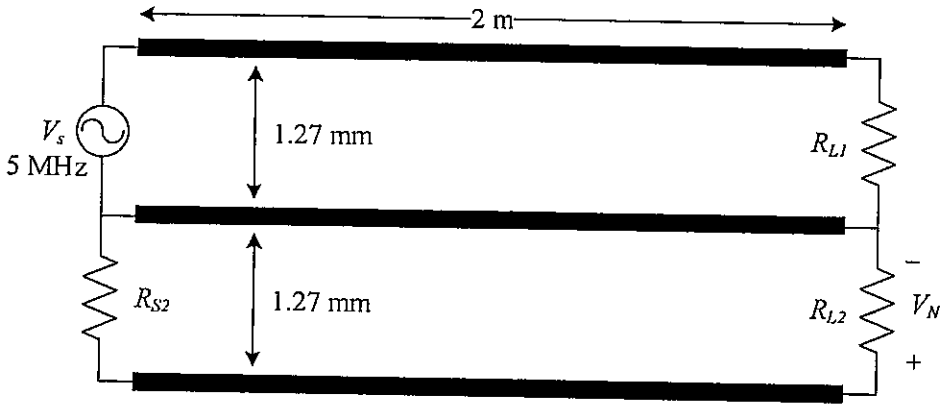

Figure Q1

Continued...

Question 2

(a) Discuss the functionalities and deployment considerations of decoupling capacitor.

[4 marks]

(b) State the differences between safety ground and signal ground.

[4 marks]

(c) The Thevenin of equivalent circuit of a load with the load current, I_L connected to the end of a power distribution bus is shown in Figure Q2. The decoupling capacitor, C_d is used to prevent load voltage, V_L, from decreasing below the minimum acceptable supply voltage, V_s. The length of the bus is 30 cm and the propagation velocity is 50% of the speed of light. Assuming the characteristic impedance, Z_0 is 50 ohm, and transient current, I_T is a step function that equals to 50 mA.

(i) Determine the maximum change in V_L for $C_d = 0.01$ μF and $C_d = 0$.

[6 marks]

(ii) Compute the required value for C_d in order to limit the change in V_L to 0.01V.

[3 marks]

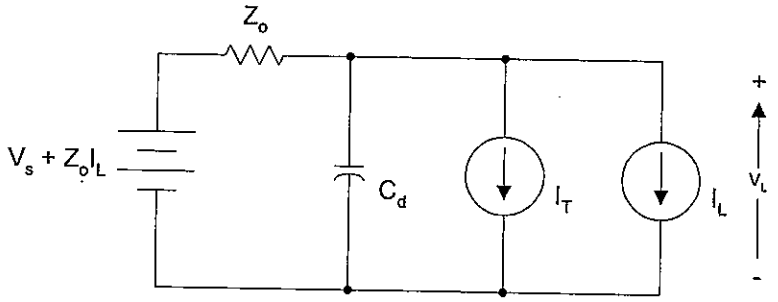

Figure Q2

(d) A practical capacitor may be represented with a model that consists of lead inductance L_{lead}, series resistance R_s, and capacitance C.

(i) Draw the circuit model of a practical capacitor.

[2 marks]

(ii) With the aid of a diagram, explain how these elements (inductance, resistance and capacitance) in the circuit model affect the impedance of the capacitor.

[6 marks]

Continued...

Question 3

(a) Shielding is applied when the source radiation or receptor susceptibility cannot be sufficiently reduced by wiring techniques.

(i) Explain the terms *skin depth* and *shielding effectiveness* in the context of cabinet shielding.

[4 marks]

(ii) The relative permeability for copper and stainless steel is 1 and 200, respectively, while their conductivity is 5.8×10^7 S/m and 1.2×10^6 S/m, respectively. If both materials are having the same thickness, justify which material is able to provide a higher absorption loss.

[8 marks]

(b) Consider a two-wire cable as shown in Figure Q3. The wires have a length of 1.2 meter and a separation of 5 mm carrying currents at 100 MHz.

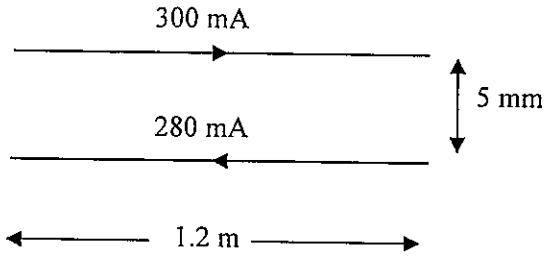

Figure Q3

At a distance of 10 m, determine:

(i) The radiated electric field due to differential mode current in V/m.

[4 marks]

(ii) The radiated electric field due to common-mode current in V/m.

[4 marks]

(iii) The total radiated electric field in V/m.

[2 marks]

(c) Suggest THREE steps that can minimize radiation due to current loops.

[3 marks]

Continued...

Question 4

(a) Name the TWO common types of test sites used for radiated emission measurement.

[2 marks]

(b) Sketch the measurement setup of an automated EMC radiated emission measurements. Explain the measurement procedure.

[13 marks]

(c) A product is tested for Federal Communications Commission (FCC) Class B radiated emission at 10 meter distance. The FCC emission limits are given in Table Q4. The antenna is connected to a spectrum analyzer using a 20 meter coaxial cable with a loss of 0.2 dB/meter. The spectrum analyzer indicates a level of 30 dBμV at 150 MHz. The antenna factor (plotted in linear scale) is given in Figure Q4.

Table Q4

Frequency	Class-A limits at 10 m	Class-B limits at 3 m
30 - 88 MHz	90 μV/m	100 μV/m
88 - 216 MHz	150 μV/m	150 μV/m
216-960 MHz	210 μV/m	200 μV/m
Above 960 MHz	300 μV/m	500 μV/m

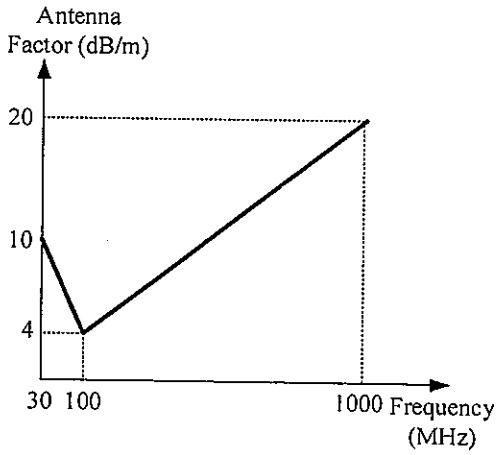

Figure Q4

(i) Determine the antenna factor in dB/m at 150MHz.

[2 marks]

(ii) Compute the electric field strength measured by the antenna in dBμV/m.

[4 marks]

(iii) Determine whether the product passes or fails the FCC Class B test, and by how many dB.

[4 marks]

End of paper